

Alternative Feeding in Iberian Pigs during Growth Period: Incorporation of Olive Cake in a Dry or Wet (silage) Form

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Summary

During the last years, the high growth of the livestock production sector has caused a high demand of raw material in order to feed the animals. This higher demand has environmental consequences and a more sustainable strategy is required for livestock production. Some agro-industrial by-products such as olive cake may be beneficially used without a decrease in production traits. Here, we studied the effect of three different dietary regimens given to Iberian pigs in growing period (42 kg to 95 kg) on several growth and slaughter traits. A control standard diet group (CD) was compared with two diets based on olive by-products, one incorporating dry olive pulp in the feed (DD), and the other one incorporating olive cake in wet form (WD). This last one consisted of olive cake in a silage presentation offered *ad libitum* and supplemented with a specific feed given once a day in a restricted regimen as the CD and DD diets. A significantly higher average daily gain during the growing period was observed for WD diet compared with DD diet. However, this was compensated with a higher average daily gain of DD pigs during the fattening period (acorn and grass). Carcass yield was lower in DD than CD and WD pigs, but no significant differences were observed for premium cut yields, which are more important for the Iberian industry. Therefore, the diets based on olive cake does not seem to alter the growth and slaughter traits studied, however, before its implementation in feeds used for the growing period, further studies analyzing their effects on meat quality and production costs should be carried out.

Key words

growing period, by-products, olive cake, Iberian pig

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Introduction

One of the most important challenges for the livestock industry consists of increasing the productivity without an increase in the production costs, minimizing the environmental impact and maximizing the animal welfare (Hume *et al.*, 2011).

The high prices of the feed raw material based on cereals have derived in a significant increase in the production costs of the farms. In addition to this, the high demand of this raw material has environmental consequences resulting in non-sustainable systems (de Miguel *et al.*, 2015). To solve this problem the use of local resources for animal feeding is a strategy that should be evaluated. Examples are by-products derived from the olive oil production that are cheap and easy to get in Spain since it is the greatest producer of olive oil in the world (Davidson, 2006).

The traditional production system of Iberian pig includes a finish-fattening period (up to 160 kg approx.) from three to five months (November to March) known as *montanera* and based on an *ad libitum* intake of acorns and grass (Lopez-Bote, 1998). However, during the growing period (up to 100 kg approx.) the diet should be restricted to avoid the animals get a percentage of fatness higher than desirable. This restriction, in our design 60% relative to *ad libitum* intake, causes animals to be subjected to behaviours related with stress (de Jong, 2000). Low energy diets would allow implementing *ad libitum* intake also during the growing period.

Although there are not many studies in pigs including olive by-products in the diet so far, these reported an improvement in the growth performance and a positive effect on the back-fat fatty acid profile producing an increase in the percentage of oleic and a decrease of the saturated fatty acids (Hernández-Matamoros *et al.*, 2011; Joven *et al.*, 2014; González-Sánchez *et al.*, 2016). Values of 54-56% of oleic acid and around 8% and 20% for linoleic and palmitic acids, respectively, are demanded by the industry for the Iberian *montanera* pigs.

The objective of the current study was to analyze the effect on growth performance and slaughter traits of two diets based on olive cake in a dry and wet form supplied during the growing period of Iberian pigs.

Material and methods

Description of the by-products

There are many types of olive by-products derived from the olive oil process. In a first place, the olive oil and the crude olive cake (COC) by-product were obtained. COC consisted of olive pulp, skin, stone and it contains a 72% of water content being a semiliquid paste. After that, there was a second extraction of the olive oil and destoning. The resulting pastry was dehydrated obtaining the olive pulp (OP) which is composed of skin, pieces of olive stones and a small part of olive oil. The analytical composition of these by-products is shown in the Table 1.

Animals and diets

A total of 45 Iberian pigs were controlled after the weaning period in terms of amount of feed supplied daily, health and general status, growth and fatness. At 6.5 months of age and with a weight of 42 kg \pm 8.6, the animals were randomly allocated

in three different pens with 15 animals per pen. The total area of the pens was 110 m² having an outdoor and a covered place.

During the growing period three feeding regimens were supplied: control (CD), dry olive pulp (DD) and wet crude olive cake diets (WD). Table 1 and 2 show, respectively, the analytical and ingredient composition of the feed used in each dietary treatment. CD diet was based on a feed (CF) formulated in order to cover the protein and energy requirements of the growing period. DD diet was based on a feed (DF) with a 45% of OP by-product in a pelleted form. Lastly, WD diet was based on two components; the first one was the COC by-product in a silage form to ease its conservation and use, and the second one, a specific feed (WF) as a complement. To prepare the silage, a mix with a 75% of COC and 25% of barley straw was made. This mix was packaged at a high pressure containing 42.5% of dry matter.

All the feeds were supplied in a pelleted form, once a day in a restricted regimen. COC by-product of the WD regimen was supplied *ad libitum*. Pigs remained on these diets up 95 \pm 13.7 kg of body weight (BW), after 191 days of receiving these feeding diets.

Table 1. Analytical composition of the Control (CD), dry olive pulp (DD) and wet crude olive cake (WD) experimental diets and by-products (OP and COC) (g/100g fresh matter).

	CD	DD	WD	OP	COC
Crude protein	17.3	14.4	24.9	10.3	7.5
Ether extract	3.6	5.7	1.7	8.4	10.8
Crude fibre B	4.1	19.1	4.9	42.0	22.0
Ashes	6.5	9.3	9.9	3.4	6.5

Table 2. Ingredient composition of the feed used in the Control (CF), dry olive pulp (DF) and wet crude olive cake (WF) experimental diets during the growing period (g/kg).

	CF	DF	WF
Barley	421.5		416
Wheat	250	110	
Extracted soybean meal 44	255	155.3	500
Animal fat	20		
Olive pulp		450	
Cereal Straw		250	
L-Lysine 50		2.2	
DL-Methionine		1	1
L-Threonine		1	1
Calcium carbonate	10		12
Dicalcium phosphate	20	15	38
Sodium chloride	8	2	14
Binder	10	10	10
Vitamin and mineral premix	5.5	3.5	8

During the finish-fattening period, the animals were fattened in *montanera* based on the *ad libitum* intake of acorns and grass. Animals were re-ordered and re-allocated in three batches according to the body weight. As the experiment was carried out with a commercial population, the regimen during the fattening

Table 3. Comparisons between Control (CD), dry olive pulp (DD) and wet crude olive cake (WD) experimental diets. Standard error of the mean (SEM) and *p*-value corresponding to the Fischer test of the ANOVA.

	CD	DD	WD	SEM	<i>p</i> -value
Growing W (kg)	94.53	89.86	100.10	13.67	0.129
ADG _G (kg)	0.279 ^{ab}	0.246 ^a	0.305 ^b	0.060	0.027
Slaughter W (kg)	160.20	164.93	161.40	8.82	0.346
ADG _F (kg)	0.547 ^{ab}	0.618 ^a	0.529 ^b	0.108	0.018
ADG _T (kg)	0.384	0.391	0.391	0.037	0.851
Carcass yield (%)	79.18 ^a	77.95 ^b	79.00 ^a	1.40	0.016
Ham yield (%)	22.04	21.94	22.34	1.15	0.314
Shoulder yield (%)	15.99	16.04	16.15	0.74	0.827
Loin yield (%)	3.20	3.37	3.16	0.29	0.107

Different superscripts indicate significant differences between diets; ADG_G: Average Daily Gain during growing period, ADG_F: Average Daily Gain during fattening period, ADG_T: Total Average Daily Gain

period had to be re-adjusted according to the availability of the acorns and grass and the weight gain. In the first batch the animals were fed exclusively with acorns and grass, in the second batch the animals were fed with acorns and grass and a daily feed supplement specific for the *montanera* period and in the third batch the animals were fed with acorns and grass exclusively until there were not enough acorns for feeding. Therefore the last weeks of *montanera* period they were fed with high-oleic feeds plus grass. Pigs remained on this diet until the slaughter with a BW of 162±8.8 kg after 118 days.

Animal manipulations were performed according to the Spanish Policy for Animal Protection RD1201/05, which meets the European Union Directive 86/609 about the protection of animals used in experimentation.

Phenotypic traits

Individual BW and feed consumption per pen were recorded every three weeks from the arrival of animals to the end of the growing period (GW). In addition, the day before slaughter the animals were individually weighed (SW). Three different estimates of the average daily gain were calculated using the different records of weights: average daily gain during the growing period (ADG_G), average daily gain during the fattening period (ADG_F) and total average daily gain (ADG_T).

The day before slaughter, animals were transported to the slaughter house. Carcass weight (CW) was individually taken at the end of the slaughter line. After two postmortem hours, weights of hams and shoulders before trimming and loins after trimming were obtained. Carcass and premium cuts yields were also estimated.

Statistical analyses

Data were analyzed with the following linear model:

$$y = Xb + e$$

where *b* represents the diet supplied during the growing period as factor (three levels) for ADG_G and GW. For ADG_F, ADG_T and carcass and premium yields a composed effect including the slaughter day and the diet supplied during the fattening period was also included as factor (four levels because first batch were slaughtered in two different days), *e* represents the residual effects. Interaction between dietary treatment during the growing

period and the batch during *montanera*, were not fitted because the number of observations prevents an equilibrated design and the data structure results in missing cells. Analyses were carried out on R environment using the functions *lm*, *anova* and *Tukey HSD*. Fischer test was applied to test effects of factors and Tukey test to make pair-wise comparisons. A *p*-value of ≤0.05 was considered as a significant difference between the different diets.

Results

Table 3 shows the mean values of the analyzed traits for each diet. Although there were no significant differences observed between the treatment groups for the most of the traits, a higher average daily gain during the growing period was observed for WD than DD pigs and, on the other hand, higher average daily gain during the fattening period was observed for DD than WD pigs. These differences were compensated when the total average daily gain was computed and no significant differences between treatments were observed. In addition, a higher carcass yield for DD was observed.

Discussion

The Spanish Standard Quality Rule of Iberian Products (RD 4/2014) demands that Iberian pigs fattened in *montanera* regimen should reach between 92 and 115 kg of weight at the end of the growing period. Furthermore, the minimum slaughter age must be 14 months with a weight gain higher than 45 kg during *montanera* regimen in not less than 60 days. In the current study, although differences for GW did not reach significance, the animals of the WD regimen had the highest GW, not exceeding the upper limit of 115 kg. In agreement with this, the average daily gain was significantly greater for the WD animals during the growing period. Therefore, the WD diet seems to give the best growth performance during the growing period. On the other hand, with DD diet pigs did not reach minimum GW of 92 kg, probably due to difficulties to fix a proper restricted ration along the growing period.

However, when growth characteristics are observed at the end of the fattening period, the differences are compensated and mean values are similar. These results agree with other studies in which the inclusion of olive cake in the diets does not affect

the growth of the animals (Benito *et al.*, 1998; Hernández-Matamoros *et al.*, 2011; Joven *et al.*, 2014).

Regarding slaughter traits, animals fed under DD diet have lower carcass yield than the animals of the other diets. The excessive development of part of the digestive tract in a particular period of the experiment with less severe restriction, could explain this difference in carcass yield. This effect of diets rich in fibre was also reported by Santomá (1997). However, there were not differences in yield of premium cuts as it was observed by other authors (Benito *et al.*, 1998; Joven *et al.*, 2014).

According to these results, the incorporation of olive cake in the diet of Iberian pigs during the growing period is advisable. The addition of crude olive cake to the diet in a form of silage seems to be more advantageous than in a dry form since it can be supplied *ad libitum*. In this way the animals feel satiated and more calm compared with CD and DD, with behaviour less noisy and nervous at the moment of the daily meal supplementation. However further studies analysing the effect of olive cake on meat quality and the cost of their supplementation in silage form should be carried out.

Conclusion

The incorporation of olive cake in the diet of Iberian pigs during the growing period has no major effect on growth and slaughter traits. Although its use seems to be suitable, further studies analyzing meat quality traits and production costs should be performed.

References

- Benito J., Vázquez-Cisneros C., Menaya C., Ferrera J. L., Romero A. and García Casco J. M. (1998) Utilización del alperujo de aceituna como suplemento de la ración en el cerdo ibérico de primer. Solo Cerdo Ibérico, 1: 45-51.
- Davidson A. (2006). The Oxford Companion to Food. Oxford, Oxford University Press.
- de Jong I. 2000. Chronic stress parameters in pigs: Indicators of animal welfare? Chapter 7. Effects of nutritional level on body temperature, heart rate and behaviour in growing pigs. Doctoral Thesis, University of Groningen.
- de Miguel Á., Hoekstra A. Y. and García-Calvo E. (2015) Sustainability of the water footprint of the Spanish pork industry. Ecological Indicators, 57: 465-474.
- González-Sánchez E., Fernández-Barroso M. A., Caraballo C. and García Casco J. M. (2016). Alimentación del cerdo ibérico con alperujo durante la recría. I Congreso Ibérico de Olivicultura, Badajoz.
- Hernández-Matamoros A., Paniagua Breña M., Izquierdo Cebrián M., Tejeda Sereno J. and González Sánchez E. (2011). Use of olive cake and tomato peel in the Iberian pig feed. XIV Jornadas sobre Producción Animal, Zaragoza.
- Hume D., Whitelaw C. and Archibald A. (2011) The future of animal production: improving productivity and sustainability. The Journal of Agricultural Science, 149. (S1): 9-16.
- Joven M., Pintos E., Latorre M., Suárez-Belloch J., Guada J. and Fondevila M. (2014) Effect of replacing barley by increasing levels of olive cake in the diet of finishing pigs: Growth performances, digestibility, carcass, meat and fat quality. Animal Feed Science and Technology, 197: 185-193.
- Lopez-Bote C. (1998) Sustained utilization of the Iberian pig breed. Meat Science, 49: S17-S27.
- Santomá G. (1997). C. d. B. B. coord. por Paloma García Rebollar, Gonzalo González Mateos. Madrid: 100-131.

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